train a technician to put the electrodes on and make the connection with the central site.

Dr Peter Gloviczki (*Rochester, Minn*). Could you comment on the role of distal ischemia on the effect of evoked potential measurements? Do you need distal perfusion or a BioMedicus pump in all of these patients to get good results?

Dr Jacobs. This is indeed extremely important. We addressed this issue many years ago by stopping distal perfusion for some minutes. In most patients, evoked potential would vanish within minutes. So distal aortic perfusion plays an important role in spinal cord protection by perfusing lumbar and hypogastric arteries during cross-clamping.

Dr Gloviczki. And could you comment on your current technique of intercostal reimplantation, whether it is a simple reimplantation or a bypass, or what do you think works the best? And do you have a number of patency of intercostal reimplantations?

Dr Jacobs. No, we do not have information on intercostal artery patency. However, our strategy is based on the evoked potentials. If we have normal 100% evoked potentials, we oversew the intercostals, except for those in the critical area between T8 and L1, where we reimplant available intercostals, because we know the lower we come in the direction of the iliac vessels during the procedure, the higher the risk will be that you will still lose the evoked potentials. This acts as a sort of a backup system. If we lose the evoked potentials completely, it is very silent in the operating room because we know that if we don't do anything about it, the patient will be paraplegic. We will perform either a bypass or reattachment of segmental vessels. Alternatively, if no intercostals are seen, we rapidly do an endarterectomy of the aortic wall, showing some back-bleeding intercostals, which will subsequently be treated with a selective graft.

Dr Roy Greenberg (*Cleveland, Ohio*). One quick question. We are used to saying that it is the thoracoabdominal aneurysm surgeon that is rare; is the neurophysiologist interpreting the motor-evoked potentials (MEPs) equally rare? How much of the interpretation is art vs science? Is it possible to look forward to computer algorithms that may help us analyze these results, thus minimizing the need for a neurophysiologist to do this? Or is this very much of an art in medicine where the level of complexity and subtlety mixed with patient idiosyncrasies precludes this development?

Dr Jacobs. Well, Roy, I will take that question with me back home and ask the neurophysiologist. It is important to realize that the neurophysiologist is not only reading the signals. If evoked potential disappears, they follow a decision tree, assessing what can cause the trouble. Is it an electrode problem? Is it anesthesia? Is it low blood pressure? Is it calcium? Is it magnesium? They go through that algorithm very quickly, which is very important since they have to assure us whether it is a technical issue or indeed a real spinal cord problem.

Dr Greenberg. There is a lot of communication going back and forth all the time.

Dr Jacobs. Absolutely.

Dr Cambria. And I'll offer a comment too. We have become very fond of this technique, and I agree with Michael that the technique is highly dependent on having an expert neurophysiology team to be sure that you have an adequate technical accomplishment of the monitoring.

INVITED COMMENTARY

Manju Kalra, MBBS, *Rochester, Minn*

Dr Jacobs and his colleagues are to be commended for this first of a kind enterprise using cyber medicine to provide remote neuromonitoring of motor evoked potentials during open thoracoabdominal aortic aneurysm repair. The authors have previously reported extensively on the use of motor evoked potentials as an adjunct for spinal cord protection during these procedures. The complexity, learning curve, and cost have limited the use of this mode of monitoring to a few tertiary centers around the world. With this study, the authors have demonstrated not only the feasibility of a central core center providing this mode of real-time neuromonitoring remotely but also its effectiveness by having achieved similar low rates of spinal cord ischemic complications in the peripheral centers as their own.

The fact that all 130 procedures were successfully performed with complete data transfer to the neurophysiologist at the central institution without time delay is incredible. A Virtual Private Network was set up to enable this, but the fact that this worked flawlessly for several hours at a time during these long procedures is almost unbelievable. Although a backup plan for direct communication with the neurophysiologist through telephone was in place in case of technical problems with the transmission, I wonder if that would have been adequate to pick up subtle changes and troubleshoot satisfactorily.

Whether this technology transfer can be duplicated in other parts of the world remains to be seen. In addition to working out the technical details of remotely providing the service, other aspects would need to be addressed. How would the providing institution be reimbursed for providing the service? Contractual agreements between the participating institutions would have to be fairly complex, given the sensitive nature of the continuous data transfer and the need for immediate action based upon changes, which were not infrequent in this study. Which institution would be liable in case of complications arising from a breakdown of data transfer? These issues would be particularly relevant in the United States with the existing model of health care delivery. They were obviously not significant deterrents to this study, as the authors do not provide any insight into them apart from pointing out the cost savings of not reduplicating the neuromonitoring capability in multiple centers. Regardless, I would like to congratulate the authors for this elegant collaborative study that is very appropriate in the current age of widespread Internet technology.